Photocathodes Activation Module Conceptual Drawing

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Godparent Committee Review

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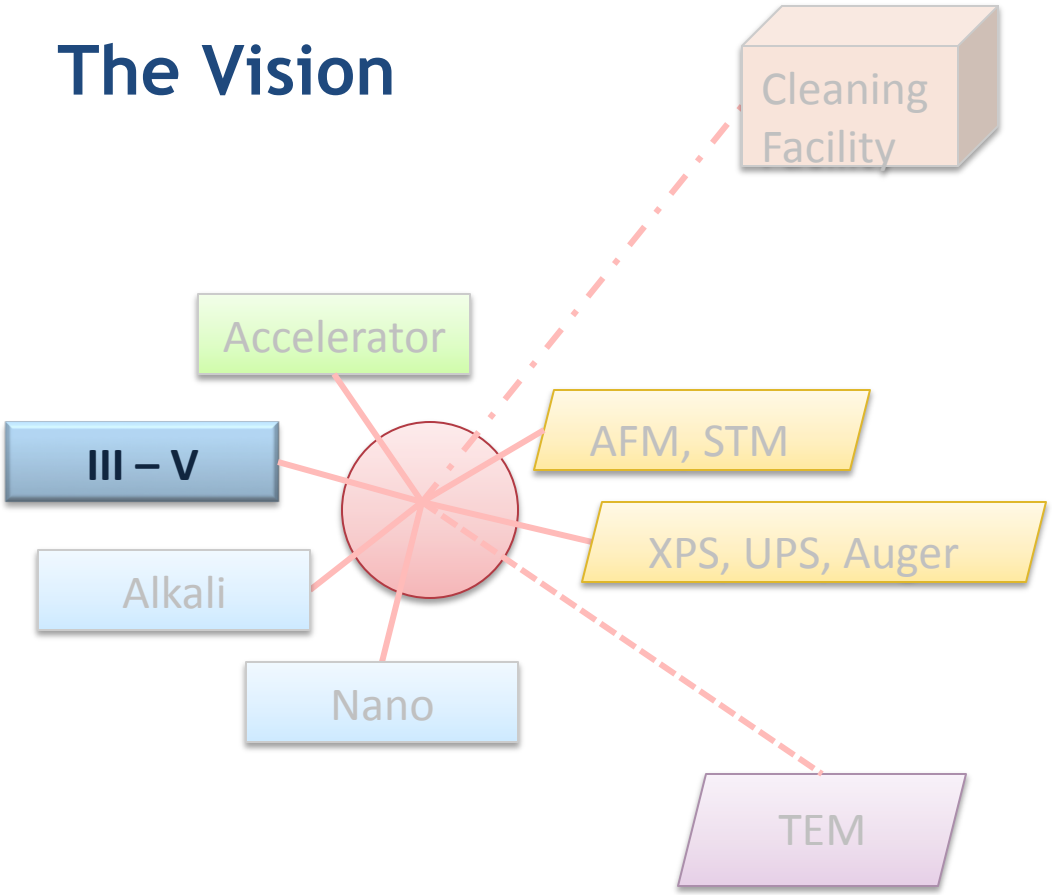
Outline

- The Vision of Photocathode Production
- Infrastructure of a Photocathode Growth / Activation Module
- Other Chamber Dimensions
- Proposed Growth / Activation Module
- QE-Characterization Chamber
- CERN Heating Unit
- Proposed Heating Unit
- Conclusion

The Vision



III – V

- Properties of Chamber
  - Load Lock
  - Cleaning
  - Growth
  - Activation
  - *In situ* Characterization

- Scope of System
  - Growth of Cathodes (variable materials)
  - Activation of Cathodes
  - *In situ* QE Characterization
  - Characterizing at Incremental Steps during Processing
    - Structure
    - Electronic state
    - Chemical composition
    - Morphology
  - Decay process of Cathode
- Technical Approach
  - Cluster System
  - Standardized Growth Chambers with minimum *in situ* characterization
  - Dedicated Complex Characterization Chambers
  - Interchangeable Units

Infrastructure of a Photocathode Growth or Activation Module

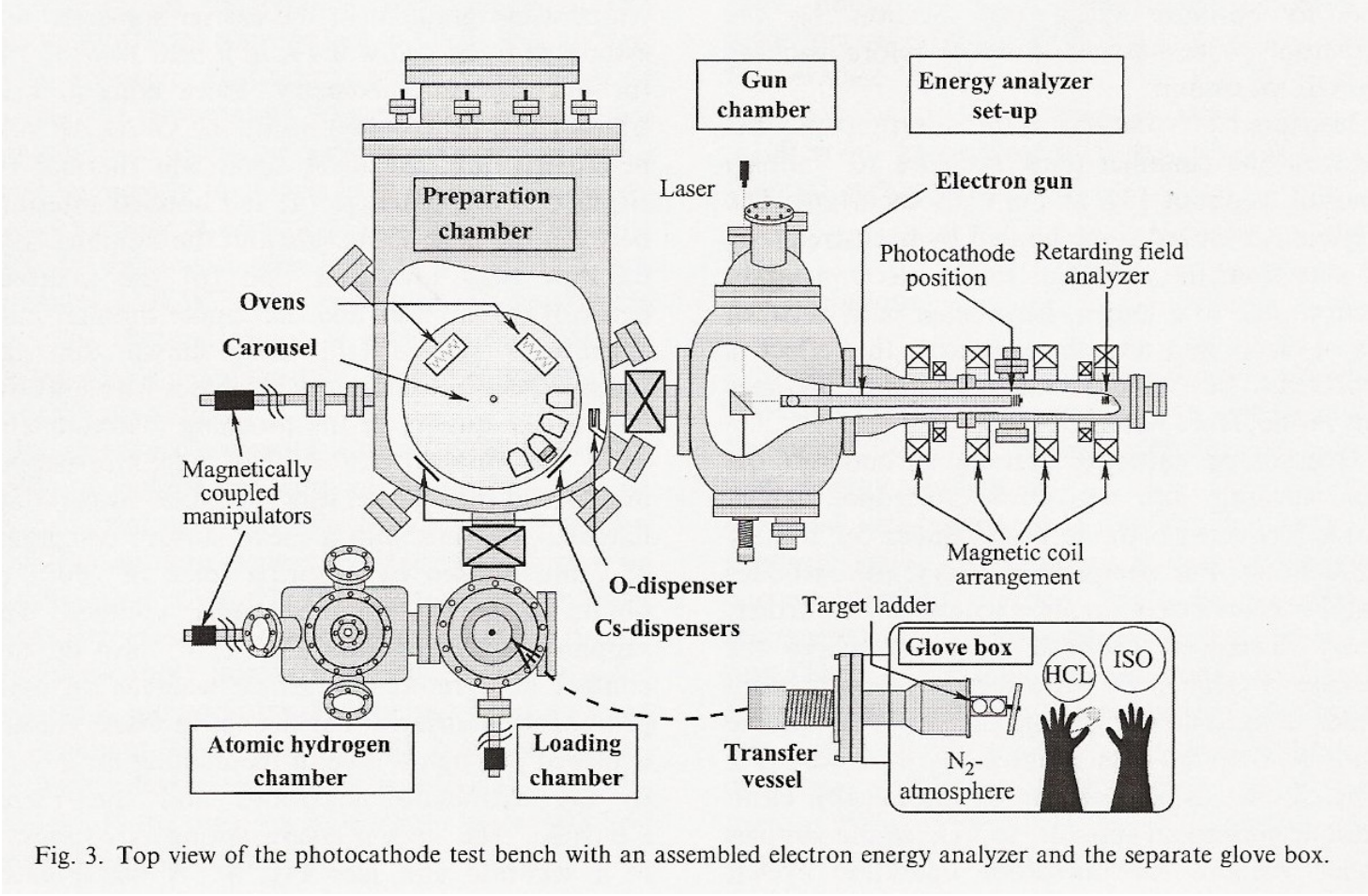
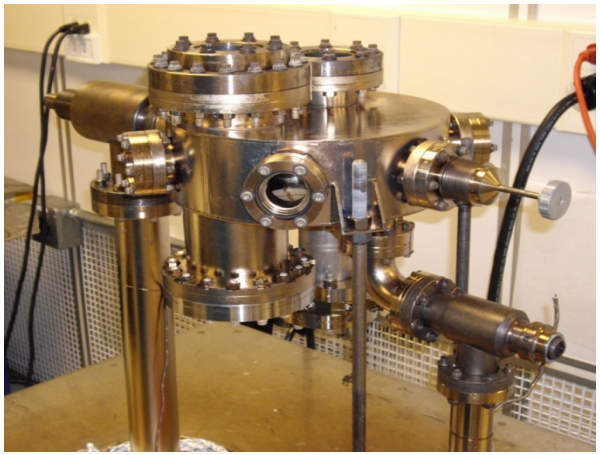


Fig. 3. Top view of the photocathode test bench with an assembled electron energy analyzer and the separate glove box.

U. Weigel, et.al. "Cold intense electron beams from LN2-cooled GaAs-photocathodes", Nuclear Instruments and Methods in Physics Research Section A . Vol. 536 pp. 323-328 (2005).

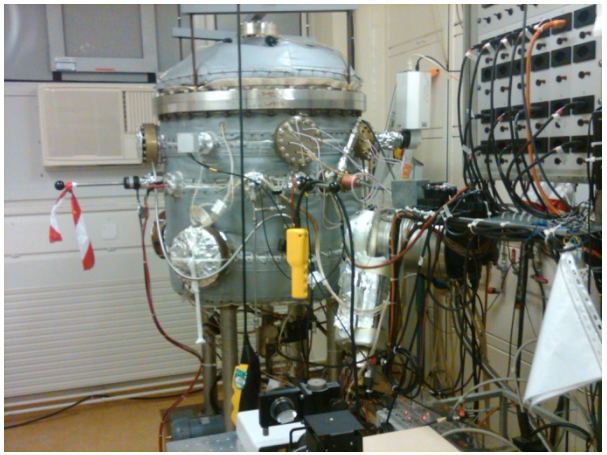
Other Chamber Dimensions

SSL



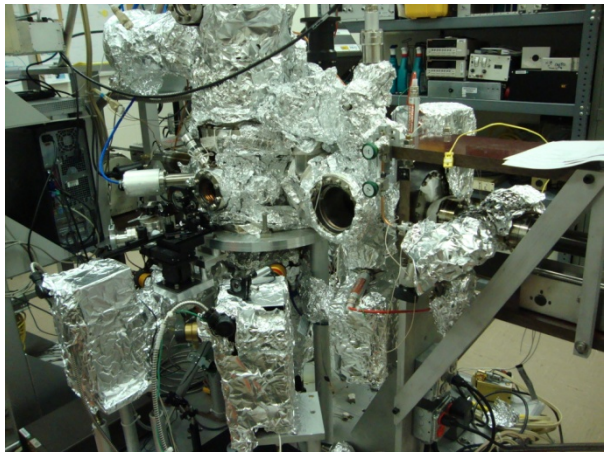
- 1 sq. ft. footprint
- Fabrication of detection system
- Minimum Characterization
- Chamber serves as Oven

CERN



- 10 sq. ft. footprint
- Fabrication of detection system
- Minimum Characterization
- Large Size Cathode (8” d)
- Minimum Oven size

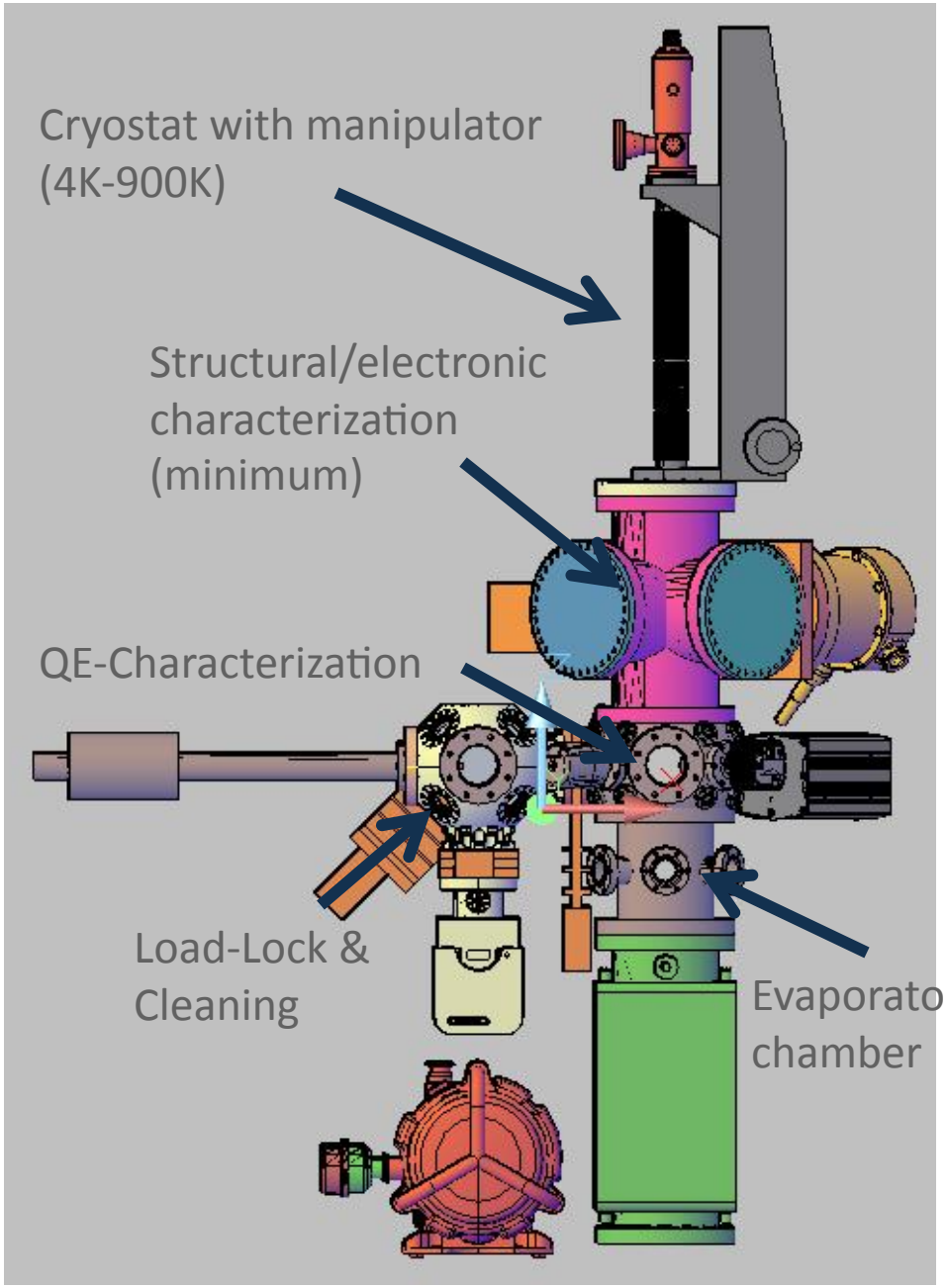
BNL



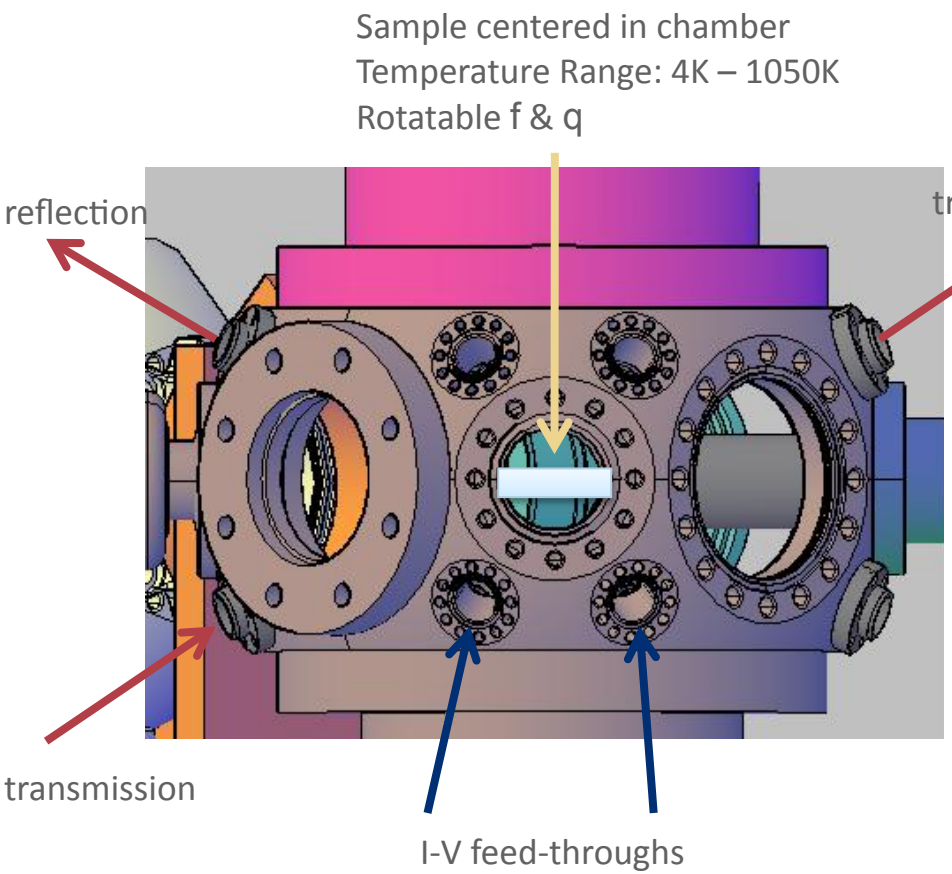
- 20-500 sq. ft. footprint
- Cathode Growth / Characterization system
- Insitu Characterization of
  - Structure
  - Chemical Composition
  - Morphology
  - Emission Properties …
- Small Size Cathode (1 sq. cm)
- Minimum Oven size

Proposed Growth/ Activation Module

- Chambers
  - Load-Lock
  - QE – characterization
    - Optic, electrical
  - Evaporator
    - 6 X 2.5” flange based
    - Boat-type, Cs, E-beam
    - O-gas source
  - Minimum structural characterization (LEED)
- Includes
  - Cleaning Facility (plasma cleaning)
  - Vacuum condition
    - Load-Lock: 10^{-7} - 10^{-9} mbar
    - Main chamber: 10^{-10} -10^{-11} mbar
  - Capability to Analyze sample sizes
    - 10x10mm^2
    - 33mm-diameter



QE-Characterization Chamber

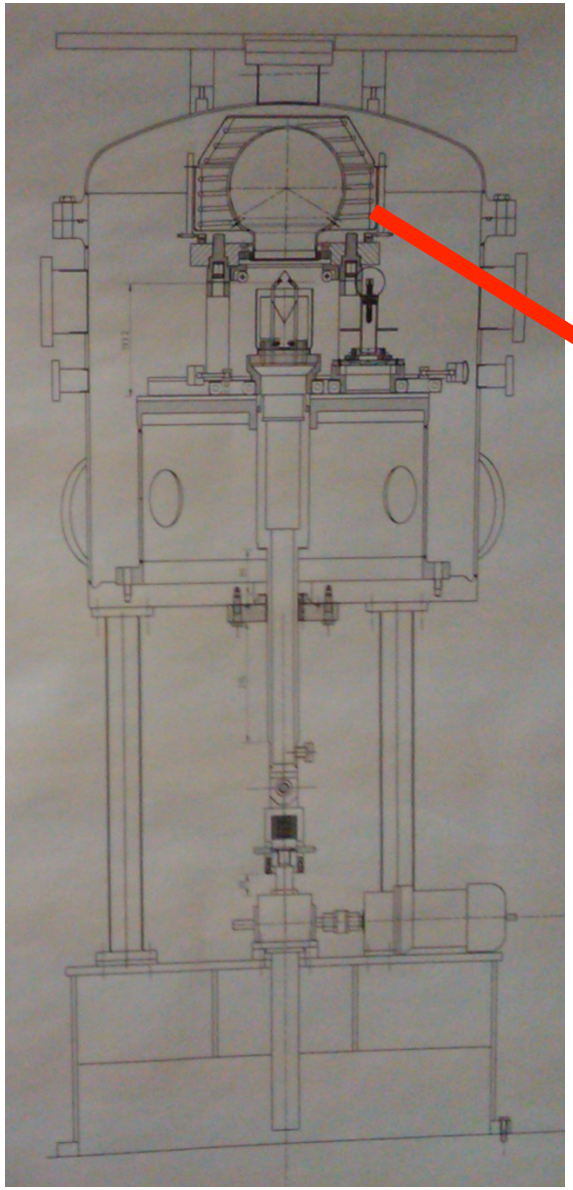


- Optic
  - Work Function
    - Temperature dependent I-V curve *
    - Spectral dependency of I-V curves*
  - Transmittance, Reflectance, Absorbance
    - Function of wavelength, specular, off-specular
    - Quantum Efficiency QE (λ)
    - Dark Current D(T)
  - Ellipsometry
    - Thickness monitor
    - *In situ* on sample
- Electrical
  - Triax / BNC Connector design
    - 1 GΩ+ Measurement
  - Measurements on Bulk and Surface
    - Resistivity (2 probe)
    - TCR (temperature coefficient of resistance)
      - Carrier Density
      - Activation Energy of dopants *

- Optional
  - Laser Characterization (Matth)

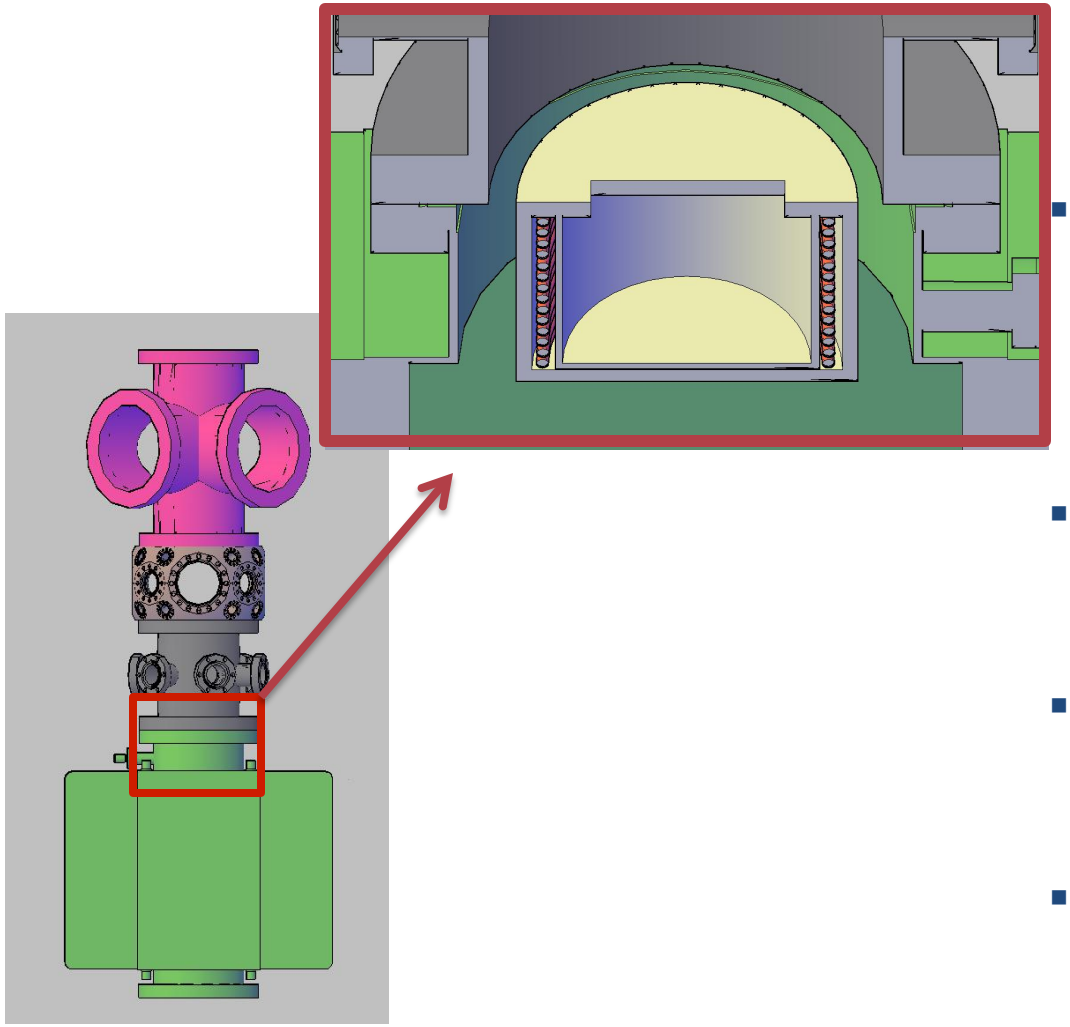
* Correlated Measurements

CERN Heating Unit



- Thermal Mass determines
  - Turnover
  - Response time
  - Vacuum quality
- Vacuum & Heater
  - Coldest chamber accumulates desorbents
  - Minimizing hot surfaces optimizes Vacuum condition
  - Open Heater v. Capsulated Heater
- Direct Heater v. Black Body Radiator
  - Homogeneity
  - Thermal mass
  - Maximal temperature

Proposed Heating Unit



- Capsulated Heater
  - T reaches and maintains up to 750° C
  - No direct contact between heating elements and sample
  - Homogeneous heating
- Furnace – Black Body Radiator
  - Heating Coils
  - Optical Furnace
- Cooling Walls
  - Absorb out gassing
  - Minimize Thermal Mass
- Single Sample holder

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